



Supporting Online Material for

Superconductivity in Hydrogen Dominant Materials: Silane

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Fig. S1

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Materials and methods

We have used diamond anvil cell equipped with beveled diamonds and gasket made of cubic BN powder mixed with epoxy. Commercial silane of 99.99% purity (Air Liquide) was loaded through capillaries into a small cavity surrounding diamonds where it was condensed at ≈ 112 -150 K. All the system was carefully checked with a helium leak detector to be ensured the absolute tightness – a necessary precaution because silane is a pyrophoric substance. After condensing silane gas at low temperatures, the cell was clamped and this process was poorly controlled. As a result, the final pressures significantly scattered and we unfortunately missed the interesting range 100-120 GPa for measurement of superconductivity (Fig. 2). Typically samples were loaded at low temperatures to different pressures and then kept at fixed loads for subsequent electrical, optical and structural measurements above 110 GPa.

Pressure was measured at low and room temperatures by the Raman shift of the high-frequency edge of the stressed diamonds (1). Temperature was measured with a calibrated Si-diode attached to the DAC. Raman spectra were collected with an HR460 monochromator equipped with a nitrogen-cooled couple charge detector (CCD). Mostly a HeNe laser with 25 mW power was used for excitation of Raman spectra. Angle dispersive X-ray diffraction studies were performed at the station 13-IDD at the Advanced Photon Source ($\lambda=0.3344$ Å).

For electrical measurements we inserted platinum leads into the hole of the insulating gasket. We measured resistance with a digital nanovoltmeter and a precision current source using van der Pauw, four- or two-probe geometry of electrodes. All these changes in resistance originate from the sample, not electrodes because all four electrodes were well separated from each other. In some measurements we used two electrodes touching the sample and branched out outside with two other electrodes. This quasi-four electrode scheme involves contribution of resistance of small piece of platinum foil. We clarified that the superconductivity could not be affected by the Pt electrodes, which follows from our measurements of the temperature dependence of resistance of platinum (Fig. S1).

We also checked if pure silicon can contribute to the observed superconductivity because decomposition of silane is not excluded (2). For that we measured resistance of pure silicon with four probes and observed sharp superconducting steps to nearly zero resistance in the 12 - 70 GPa range. We found a good agreement with the known data (3) except that at 40 GPa we measured slightly higher $T_c = 5.8$ K. In the 70-115 GPa range we did not find any superconductivity with $T_c > 3.5$ K (the lower limit of our setup). During the measurements all four electrodes were in order and we measured $T_c = 5$ K at 45 GPa at releasing pressure. Thus input of silicon to the measured superconductivity is ruled out.

We found, however, that decomposition can indeed occur when silane was loaded at $P < 50$ GPa and warmed to room temperature. In this case we clearly observed Si at the X-ray diffraction patterns, and the H_2 vibron in Raman spectra even not from transparent but metallic sample at higher pressures. Thus, we avoided decomposition by loading silane and performing further measurements at low temperatures below 120-150 K. We warmed the sample up to 300 K only at pressures above 100 GPa. X-ray diffraction measurements proved that no Si phase appeared in this case. It is important that with our sensitive Raman setup we observed no hydrogen vibrons either in the sample or in the surrounding transparent cBN gasket.

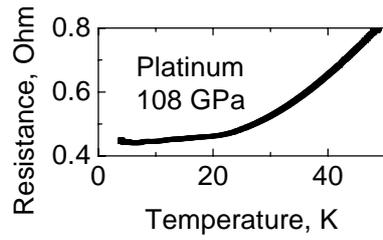


Fig. S1. Temperature dependence of the resistance of the platinum foil shows no evidence of a superconducting transition at 108 GPa at $T > 4$ K. The Pt foil of thickness $2.5 \mu\text{m}$ and $5 \mu\text{m}$ wide of $80 \mu\text{m}$ length was measured with the 4-probe method in a separate run with the cBN-epoxy pressure medium.

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